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# Cooperation in Polygynous Households[†]

*By* Abigail Barr, Marleen Dekker, Wendy Janssens, Bereket Kebede, and Berber Kramer*

*Using a carefully designed series of public goods games, we compare, across monogamous and polygynous households, the willingness of husbands and wives to cooperate to maximize household gains. Compared to monogamous husbands and wives, polygynous husbands and wives are less cooperative, one with another, and co-wives are least cooperative, one with another. The husbands' and wives' behavior in a corresponding series of inter-household games indicates that these differences cannot be attributed to selection of less cooperative people into polygyny. Finally, behavior in polygynous households is more reciprocal and less apparently altruistic.* (*JEL* C93, D13, J12, O12)

Many programs aimed at reducing poverty in low and middle income countries (LIMCs) involve transfers to households of either cash or in-kind resources (Morduch 2011; Baird et al. 2014; Banerjee et al. 2015; Banerjee, Karlan, and Zinman 2015). The optimal design of such programs depends on how decisions are made within households. Understandably, considerable attention has been given to the issue of whether positive effects on children's and other household outcomes are greatest when the transfer recipient is the husband or the wife (e.g., Thomas 1990, 1994; Duflo 2003; Yoong, Rabinovich, and Diepeveen 2012; Benhassine et al. 2015; Akresh, de Walque, and Kazianga 2016; Ambler 2016) and, relatedly, to husband-wife differences in resource allocations and to spousal cooperativeness (e.g., Manser and Brown 1980; McElroy and Horney 1981; Browning et al. 1994; Udry 1996; Iversen et al. 2011; Bezu and Holden 2015).

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However, as the rollout of such programs in Africa gathers momentum (Garcia and Moore 2012), another issue is beginning to loom large: that of how such programs should be adapted to accommodate *polygynous* households. In some countries in sub-Saharan Africa, many in West Africa, over 40 percent of women are in polygynous marriages (Elbedour et al. 2002, Dalton and Leung 2014). This is raising new challenges for policy makers interested in optimizing program impacts and highlighting gaps in our understanding of how decision-making differs between polygynous and monogamous households (Van Domelen and Coll-Black 2010, Baland and Ziparo 2017).

In this paper, we investigate whether and how spousal cooperativeness differs between monogamous and polygynous households. We hypothesized that cooperation would be lower within polygynous households. Our reasoning was as follows. Polygyny is associated with higher male premarital social and/or economic status and, hence, better ex ante prospects (e.g., Hames 1996, Zeitzen 2008, Chaudhary et al. 2015). However, it is also associated with worse welfare outcomes, especially for junior wives and their children, even after controlling for household resources and number of children (Amey 2002, Hadley 2005, Tertilt 2005, Bove and Valeggia 2009, Gyimah 2009, Shepard 2013). The gap between ex ante prospects and ex post welfare outcomes suggests that polygynous households are less efficient, and this could be owing to the members of such households being less cooperative.

Cooperation could be lower in polygynous compared to monogamous households for many reasons including competition between co-wives, larger spousal age gaps, reduced paternity certainty, and lower genetic relatedness (Jankowiak, Sudakov, and Wilreker 2005; Henrich, Boyd, and Richerson 2012). Compared to monogamous spouses, members of polygynous marriages, in particular co-wives, have been found to engage in more self-serving strategic behavior. For instance, polygynous wives strategically raise their fertility in response to an increase in the fertility of their co-wives in order to maintain bargaining power over resources controlled by the husband (Rossi 2016); and co-wives have been found to be more conditional in their cooperativeness, one with another, compared to husbands and wives, when cultivating land for household consumption (Akresh, Chen, and Moore 2012, 2016).

By inviting spouses to make decisions with real monetary consequences in a series of two-person public goods games (PGGs), we generate directly comparable measures of the extent to which husbands cooperate with their wives, wives with their husbands, co-wives with each other, and husbands and wives with members of other households. We compare cooperation across monogamous and polygynous households and investigate whether cooperation within polygynous households varies depending on who is interacting with whom. Using data on participants' beliefs about others' cooperativeness, we also undertake a preliminary investigation into whether the differences in cooperation can be explained by differences in how husbands and wives condition their own cooperativeness on their beliefs about the cooperativeness of their spouses and co-wives.

Overall, we find high contribution rates in *intra*-household games, but in polygynous husband-wife pairs, we find lower contribution rates than in monogamous husband-wife pairs, and contribution rates are even lower in co-wife pairs. In games with adults from other households, contribution rates are much lower and do not

differ between monogamous and polygynous household members, suggesting that the difference in *intra*-household contribution rates are owing to an effect of the marriage institution rather than the selection of less cooperative people into polygyny. Further, we find that there are differences across the household types in the way husbands and wives condition their cooperativeness on how much they believe their spouses and co-wives will cooperate. Specifically, behavior in polygynous households is more reciprocal and less apparently altruistic than in monogamous households. This is consistent with findings from studies using observational data (Akresh, Chen, and Moore 2012, 2016; Rossi 2016).[1] Our experiment complements these field-based studies as it allows us to investigate *intra*-household cooperation in a controlled environment and make informative ceteris paribus comparisons between intra- and inter-household cooperation.

This paper contributes to the growing literature on cooperation between spouses in lab-type experiments. Most of the studies in this literature focus on monogamous households (Peters et al. 2004; Mani 2011; Iversen et al. 2011; Castilla and Walker, 2013; Cochard, Couprie, and Hopfensitz 2016; Kebede et al. 2014; Munro et al. 2014; Castilla 2015; Beblo and Beninger 2017). To our knowledge, the only other experimental study looking at *intra*-household cooperative efficiency in polygynous households is by Munro et al. (2010). However, they investigated neither differences in behavior across the various dyads within polygynous households nor differences in *inter*-household cooperation.

The remainder of this paper is structured as follows. The next section presents our experimental design and procedures. Section II presents the main results. Section III concludes.

## I. Methods

### A. *Participant Sample and Study Context*

The experiment was conducted in Kwara State, Nigeria, in June and July 2013 as a complement to a panel survey of 613 adults of whom 492 were married. During the final survey round, all adult respondents were invited to participate in a workshop to investigate how people make decisions about money. Of the 492 married invitees, all but four showed up. The six spouses of the four no-shows were excluded from the analysis. Also excluded from the analysis were the members of one household with two co-wives but no husband and eight polygynous households with three wives. The final analysis sample consisted of 448 married individuals who were in either monogamous (110 men, 110 women) or polygynous marriages involving two wives (76 men, 152 women).

[1] In fact, Akresh, Chen, and Moore (2012, 2016) finds that where reciprocity is greater, cooperation is higher. However, they focus on a decision-making context in which contributions are observable, so, free-riding is punishable and threats of punishment sustain cooperation. Altruism in this context undermines cooperation because it undermines individuals' ability to credibly threaten to punish. In contrast, we focus on a context in which contributions cannot be observed, and free-riding cannot be punished. In this context, altruism supports cooperation, ceteris paribus, and so too does reciprocity, but only if it is accompanied by a belief that the other will also cooperate.

Most of the participants were from the Nupe ethnic group, the majority ethnic group in Niger State and an important minority in Kwara state. There are approximately 3.5 million Nupe and they live in central and northern Nigeria.[2] Their geographical proximity to the Yoruba, the second largest ethnic group in Nigeria, has led to many cross-cultural influences. Living arrangements among Nupe and Yoruba people in northern Kwara state are comparable, based on patrilineal and patrilocal family structures in which polygyny is common (Ajadi et al. 2015).

Nupe marriages are usually arranged, rarely formally registered, and almost always involve a bride-price (Nadel 1942). The bride-price is an exchange of resources for rights over a woman and a confirmation of the bonds between two families and kinship groups. The bride-price transaction has the significance of a contract to which the two families are guarantors (Nadel 1942, Katcha 1978). The number of wives a man has is an indicator of wealth and status (Nadel 1942). Both deuterogamy (i.e., marrying the wife of a deceased brother) (Ajadi et al. 2015) and divorce are common in Nupe culture (Katcha 1978).

Polygynous families tend to co-reside, although each wife (with her children) usually occupies her own room or group of rooms within the compound and shares meals principally within her own nuclear household (Katcha 1978). Formally, the Nupe adhere to the maximum of four wives stipulated by the Quran to ensure equal treatment of each wife. However, informally, more partners are allowed, for example, in the form of concubines or older ex-wives who remain in the family compound, and inequalities between spouses are tolerated (Nadel 1942; Strassmann 1997; Ukwuani, Cornwell, and Suchindran 2002).

Individuals in our study area are predominantly involved in farming, trading, and agriculture-related business. Thirty percent of married women work as farmers or farm laborers, while 60 percent are traders. Despite similarities between Yoruba and Nupe (see also Oni 1996), rural Nupe women have somewhat greater agency over productive resources compared to their Yoruba neighbors (Ajadi et al. 2015). Decision-making power is tilted toward Nupe men in what types of crops to grow, which agricultural inputs to purchase, and whether to sell land and large livestock, and toward Nupe women in the sale of smaller animals (goats, chicken) and when to take crops to the market. Women generally generate and keep part of their own income.

Table 1 provides descriptive information about our participant sample. Notable differences across the monogamous and polygynous subsamples are that polygynous households are larger, polygynous husbands have more children, and the wives of polygynous husbands tend to be less educated. Moreover, polygynous households are more likely to be Muslim and reside in rural areas. We will control for these differences in the analyses.

[2] See https://en.wikipedia.org/wiki/Nupe_people, accessed August 1, 2018.

Table 1—Participant Sample Characteristics

| | Monogamous | | Polygynous | |
|---|---|---|---|---|
| Variable | Male | Female | Male | Female |
| Age | 48.38 | 37.89 | 48.42 | 36.81 |
| Household size | 5.527 | 5.527 | 8.934 | 8.934 |
| Education (years) | 6.771 | 2.783 | 6.173 | 1.553 |
| Education (category): | | | | |
| No education | 0.342 | 0.642 | 0.361 | 0.757 |
| (Some) primary completed | 0.181 | 0.226 | 0.253 | 0.204 |
| (Some) secondary completed | 0.248 | 0.085 | 0.173 | 0.039 |
| Higher education | 0.229 | 0.047 | 0.213 | 0.000 |
| Nupe | 0.914 | 0.915 | 0.960 | 0.974 |
| Muslim | 0.867 | 0.840 | 0.960 | 0.954 |
| Earning | 0.952 | 0.896 | 0.973 | 0.927 |
| Wealth | −0.001 | −0.001 | −0.080 | −0.080 |
| Urban | 0.318 | 0.318 | 0.105 | 0.105 |
| Number of children | 4.818 | 4.818 | 8.680 | 4.309 |
| Comprehension of game | 3.682 | 3.745 | 3.697 | 3.671 |
| Observations | 110 | 110 | 76 | 152 |

*Notes:* Age = age in years; household size = number of household members; education = years of formal education completed; Nupe = 1 if participant belongs to Nupe ethnic group; Muslim = 1 if participant Muslim; earning = 1 if participant brings monetary income into household; wealth = household-level asset index; urban = 1 if household is in an urban area; number of children = reported by wives (for monogamous husbands, we use number reported by their wife; for polygynous husbands, we use the sum of the number of children reported by first and second wife); and comprehension of game = number (out of four) of test questions about game correctly answered.

### B. *Experimental Task*

Each participant played a series of linear two-person public goods games (PGGs). At the start of each game, a participant was given an initial endowment. Initial endowments varied and were known only to the recipients.[3] With a 95 percent probability, a participant's initial endowment was 220 Naira (₦220) in each game (approximately US$1.50, one-third of median daily cash income).[4] However, each participant faced a 5 percent chance of receiving an initial endowment between ₦180 and ₦20. The range of possible initial endowments was common knowledge, but participants did not know the probabilities associated with each.

Each participant then had to decide, in private, how much of that initial endowment to contribute to a shared fund and how much to keep. The money they chose to keep they could put in their pocket straight away. Once both playing partners had made their contributions, the shared fund was multiplied by 1.5 and divided equally between the two. Participants maximized their joint earnings from the game by contributing their entire initial endowment to the shared fund. However, a participant maximized individual earnings, given any playing partner's contribution, by contributing nothing and going home with his or her own initial endowment plus three-quarters of the partner's contribution.

Each participant played the PGG three times, each time with a different playing partner. Every monogamous husband (wife) played one game with his (her)

[3] This gave spouses a chance to hide money from each other.

[4] The median daily cash income from employment, agriculture, and business for the participant sample was ₦600. The exchange rate at the time of the games (July 2013) was US$0.615 = ₦100.

wife (husband). Every polygynous husband played one game with each of his two wives. Every wife of a polygynous husband played one game with her husband and one with her co-wife. In addition, monogamous (polygynous) spouses played their remaining two (one) games with an adult from another household (*inter*-household).

At the start of each *intra*-household PGG, participants were told the precise identity of their playing partner. At the start of each *inter*-household PGG they were told that they were playing with "a man" or "a woman" in the same workshop. Hence, participants in the *inter*-household games played with adults from other households *and* they did not know their playing partners' identities, only their gender.[5]

The order of the games was randomized and participants received no indication that husbands, wives, and co-wives would play together until the start of their first *intra*-household game. These design details both minimized the likelihood of, and allowed us to investigate and rule out the possibility that participants played their three games as a portfolio rather than as a series of separate interactions. Ruling out portfolio decision-making is important because, in the presence of such decision-making, any observed behavioral differences across monogamous and polygynous households could be owing to the former playing only one *intra*-household game, while the latter played two. For instance, polygynous husbands and wives could contribute differently from monogamous husbands and wives owing to differences in total expected earnings from the three games.[6]

After playing all three games, participants were asked to guess how much their partner in each game contributed, assuming an initial endowment of ₦220. The beliefs were not elicited before playing the games to avoid priming the participants to think specifically about strategic considerations.

Participants received their earnings from the three shared funds to which they could have contributed as a single payment with no breakdown at the end of the workshop. Because of this and the fact that participants' initial endowments were known only to themselves, participants could contribute significantly less than their initial endowments while claiming to have contributed all.

### C. *Procedures*

A single team conducted the workshops in all 16 communities. In each workshop, the participants received training in the PGG as a group. Then, during one-to-one interviews, each participant's comprehension was tested and their contribution decisions elicited.[7] Once all the participants had made their decisions, each was paid in private. At every stage of a workshop the team followed a script and detailed protocol. The workshops were conducted entirely in Nupe.[8]

In most communities, two workshops were conducted, both on the same day. The exceptions were two small villages where a single workshop was planned due to

[5] Had we revealed the identity of the *inter*-household playing partners, both their reputations and the characteristics of their relationships, while unknown to us, would have affected contribution decisions.

[6] In online Appendix Section 3, we test for portfolio effects and show that they are not driving our results.

[7] Comprehension of the game was good with more than 90 percent of test questions correctly answered.

[8] See online Appendix Section 6 for English translations of the scripts, the corresponding visual aids, and the detailed protocol.

small sample size, four villages in Shonga district in each of which the two planned workshops were amalgamated into one for logistical reasons, and one town (Lafiagi town) in which three workshops were held due to large sample size. Participants were randomly assigned to one of the workshops in their community. On average, a workshop involved 28 participants (minimum 8, maximum 50) and participants earned around ₦847 from the games plus a ₦250 show-up fee.

Substantial care was taken to avoid communication within workshops and spillovers within and between communities. The workshops took place in community buildings, such as schools or health or community centers, with at least two separate rooms. The group training was given to all the participants in one room. The second room was used as a waiting room for those who had completed their interviews. Pre-planned seating arrangements in the training room ensured that marriage groups (spouses as well as co-wives) were separated. Participants were not allowed to talk to each other until they had finished their individual interviews and reached the waiting room, where they received a drink and a snack.

Participants in the two workshops in a community were not allowed to mix to avoid communication.[9] Workshops within a single district were planned such that they would start the day *after* the weekly market day in that district. Spillovers between communities on days other than market days were expected to be very limited.

## II. Results

### A. *Contribution Rates by Marriage Type*

Panel A of Figure 1 presents the distributions of contribution rates for monogamous and polygynous spouses and co-wives when playing one with another, within households, and the bars in panel B present the corresponding mean contribution rates. The test result in panel B pertains to the null hypothesis that mean contribution rates do not differ across polygynous and monogamous marriage groups.

Overall, *intra*-household contribution rates are high. Panel A reveals that within both household types, most spouses contributed their entire initial endowment. However, panel B indicates that polygynous marriage group members were, on average, significantly less cooperative, one with another, compared to those in monogamous marriages ($p = 0.047$). On average, monogamous spouses contributed 88 percent of their initial endowment to the shared fund, while polygynous spouses contributed only 78 percent.[10]

[9] In Lafiagi, the third workshop was held on a second, consecutive day. Participants in Lafiagi were dispersed across neighborhoods, limiting potential communication between participants assigned to different workshops.

[10] The decisions made in the *intra*-household PGGs reflect both a willingness to make financial contributions to the common pot and, working in the opposite direction, a willingness to hide personally held resources. We find a correlation between decisions made in the *intra*-household PGGs and how much participants know about each other's finances in everyday life, but no correlation with financial contributions to household expenditures. For further details, see Section 5 of the online Appendix.

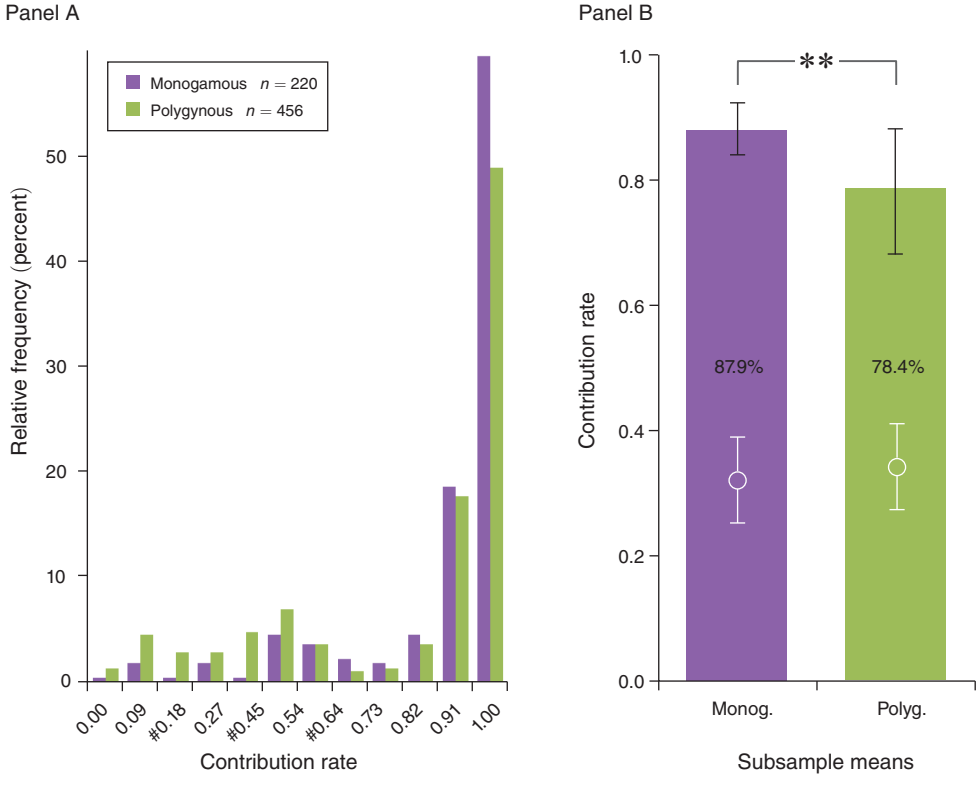


FIGURE 1. CONTRIBUTIONS TO THE SHARED FUND BY MONOGAMOUS AND POLYGYNOUS SPOUSES

*Notes:* Contribution rate is the amount contributed to the shared fund as a proportion of initial endowment. Each observation is a contributing decision. Panel A presents the distributions of contribution rates for monogamous spouses when playing together (dark, purple) and polygynous husbands and their wives when playing in pairs (husbands with wives or co-wives together) (light, green). Panel B presents the mean contribution rates. The black vertical whiskers are 95 percent confidence intervals generated using a linear regression of contribution rates on polygyny, in which interdependence within workshops is accounted for using a wild bootstrap (Cameron, Gelbach, and Miller 2008). The test result indicated by the horizontal bracket at the top of the panel is derived from the same regression: ** = difference significant at the 5 percent level. The circle and whiskers in white within each bar indicate the mean and 95 percent confidence interval of the contribution rate for the same participant subsample, but when playing with members of other households. # = bin expanded to accommodate slightly higher and lower contribution rates owing to initial endowments not always equaling 220 naira.

## B. *Contribution Rates by Participant and Playing Partner Type*

Next, we investigate whether cooperation within each household type varies systematically depending on who is interacting with whom. Figure 2 presents the mean contribution rates for each type of husband and wife when interacting with their spouses and, in the case of wives of polygynous husbands, their co-wives. The figure also presents the results of a series of comparison-of-means tests focusing on various pairs of defined subsamples.[11]

[11] These test results were derived from the regressions presented in online Appendix Table A1.

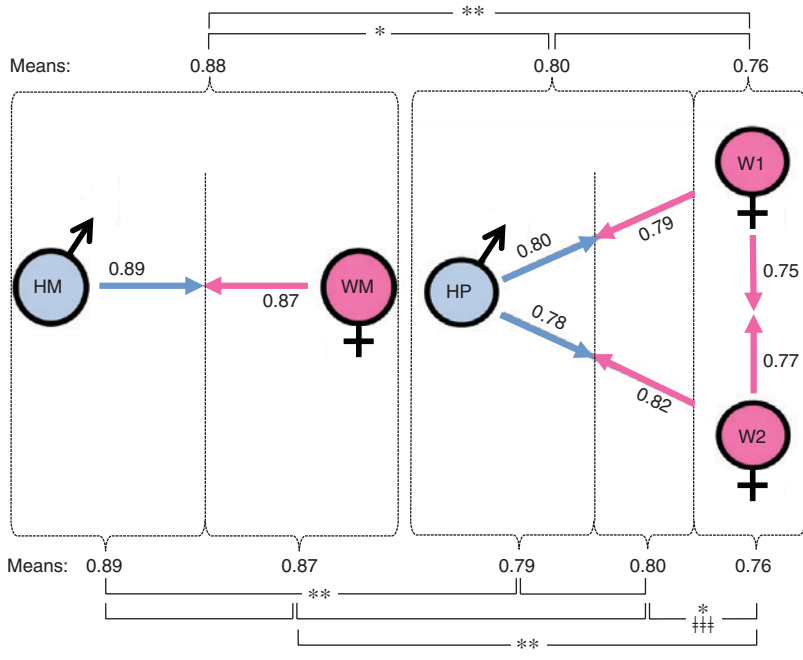


FIGURE 2. CONTRIBUTIONS TO THE SHARED FUND BY MARRIAGE, SPOUSE, AND PLAYING PARTNER TYPE

*Notes:* The Mars symbols (blue) indicate husbands. The Venus symbols (pink) indicate wives. HM = monogamous husband; WM = monogamous wife; HP = polygynous husband; W1 = first wife of a polygynous husband; W2 = second wife of a polygynous husband. An arrow emanating from one symbol in the direction of another indicates the contributions made by spouses of former symbol type when playing with spouses of latter symbol type. The proportion inscribed on each arrow is the mean contribution rate. The means listed above and below the diagram are for pooled subsamples defined by the vertical dotted lines and corresponding braces. The test results on the horizontal square brackets above and below these means are derived from a series of linear regressions presented in online Appendix Table A2 in which dependence within workshops is accounted for using a wild bootstrap. Within each pooled subsample (defined by vertical dotted lines and braces), the regressions indicate that the contribution rates can be pooled. ** = significantly different at the 5 percent level according to the pooled regression analysis; * = significantly different at the 10 percent level according to the pooled regression analysis; ‡‡‡ = significantly different at the 1 percent level according to a within-wife analysis. There are 676 observations.

Figure 2 indicates that, when playing with their spouses, polygynous husbands and wives contributed significantly less than monogamous husbands and wives: 80 percent on average compared to 88 percent ($p = 0.051$). Further dividing the sample reveals that, when playing with their wives, polygynous husbands contributed significantly less than monogamous husbands: 79 percent on average compared to 89 percent ($p = 0.033$). In contrast, the difference between the contributions made by the wives of monogamous and polygynous husbands when playing with those husbands was not significant: 87 percent compared to 80 percent ($p = 0.133$).

The figure also indicates that, while the contribution rates of wives in polygynous marriages playing with their husbands were statistically indistinguishable from their husbands' contribution rates (80 percent compared to 79 percent), the contribution rates of co-wives when playing with each other were significantly lower at 76 percent ($p = 0.068$ in a pooled analysis, $p < 0.001$ in a within-wife (fixed effects) analysis).

To sum up, Figure 2 reveals that the lower contribution rate in polygynous households compared to monogamous households was driven by two factors. First, when playing with their spouses, polygynous husbands and wives contributed significantly less than monogamous husbands and wives, with the difference being driven primarily by husbands. Second, when co-wives played together, their contribution rates were significantly lower than when they played with their husbands.

### C. *Controlling for Other Factors*

Next, we investigate whether the differences described in IIA and IIB are owing to cross-subsample variations in the participants' experiences during the experimental sessions or individual characteristics. Column 1, Table 2, presents the regression results supporting the key comparison-of-means findings already described.[12] Column 2 presents the same set of regression results but after socioeconomic and experimental controls have been added.[13]

In panel A, adding these controls has very little impact on the size and significance of the mean difference in contribution rates between monogamous and polygynous marriage group members when playing *intra*-household games. The same applies when focusing on husband-wife interactions only in panel B.

In panel C, adding controls reduces the size and significance of the difference between monogamous and polygynous husbands. Indeed, once the controls are added, we can no longer reject the null that monogamous and polygynous husbands are equally cooperative when interacting with their wives. This loss in significance is owing entirely to the inclusion of number of children in the regression.[14] This is suggestive of a possible mechanism driving the mean difference. However, when number of children is included, while the $p$-value on the *Polygynous* identifier increases to 0.120 (just insignificant), the $p$-value on the number of children variable is 0.950, indicating a loss of power owing to multicollinearity rather than mechanism identification. The *Polygynous* identifier and the number of children variable are, indeed, highly correlated ($p = 0.038$, see Table 1 for subsample means).

Panel D focuses on wives' contributions only, and includes a variable for polygynous wives playing with a female playing partner ($P \times FPP$) to identify the difference in the cooperativeness of polygynous wives depending on whether they are interacting with their husbands or their co-wives. When controls are added, the difference between wives of monogamous and polygynous husbands (indicated by the coefficient on *Polygynous*) increases and becomes significant at the 5 percent level ($p = 0.034$). This gain in significance cannot be attributed to the inclusion of any one specific control.[15] The inclusion of controls does not affect the significant

[12] The within-wife, fixed effects regression is omitted in the interest of brevity.

[13] See online Appendix Section 2 and Tables A2–A5 for definitions of control variables and the results of the regressions with controls in full. See online Appendix Section 3 and Tables A6–A8 for analyses including further controls that allow us to rule out portfolio decision making.

[14] See online Appendix Table A4. The number of children with *the playing partner* (instead of total own number of children) and its interaction with *Polygynous* are not significant either (results available upon request).

[15] See online Appendix Table A5.

Table 2—Intra-household and Inter-household Contribution Rates by Player Type

| Dependent variable (DV) = contribution rate = contribution/initial endowment | Intra-household no controls (1) | | Intra-household with controls (2) | | Inter-household no controls (3) | | Inter-household with controls (4) | |
|---|---|---|---|---|---|---|---|---|
| *Panel A. Husbands' and wives' contributions* | | | | | | | | |
| Polygynous (P) | −0.095 | (0.047) | −0.099 | (0.024) | 0.026 | (0.329) | 0.034 | (0.319) |
| Observations | 676 | | 663 | | 668 | | 648 | |
| *Panel B. Husbands' and wives' contribution in husband-wife interactions only* | | | | | | | | |
| Polygynous (P) | −0.083 | (0.051) | −0.076 | (0.045) | N/A | | N/A | |
| Observations | 524 | | 511 | | | | | |
| *Panel C. Husbands' contributions only* | | | | | | | | |
| Polygynous (P) | −0.100 | (0.033) | −0.080 | (0.120) | $3.7e^{-4}$ | (0.991) | 0.027 | (0.687) |
| Female playing partner (FPP) | N/A | | N/A | | −0.023 | (0.378) | −0.020 | (0.422) |
| P × FPP | N/A | | N/A | | 0.092 | (0.289) | 0.063 | (0.526) |
| Sum of coeffs. on P + (P × FPP) | N/A | | N/A | | 0.092 | (0.323) | 0.089 | (0.453) |
| Observations | 262 | | 253 | | 296 | | 284 | |
| *Panel D. Wives' contributions only* | | | | | | | | |
| Polygynous (P) | −0.066 | (0.133) | −0.091 | (0.034) | −0.008 | (0.890) | 0.002 | (0.960) |
| Female playing partner (FPP) | N/A | | N/A | | −0.008 | (0.756) | −0.019 | (0.333) |
| P × FPP | −0.043 | (0.068) | −0.044 | (0.076) | 0.045 | (0.465) | 0.042 | (0.552) |
| Sum of coeff.s on P + (P × FPP) | −0.109 | (0.029) | −0.134 | (0.007) | 0.037 | (0.657) | 0.044 | (0.626) |
| Observations | 414 | | 410 | | 372 | | 364 | |

*Notes:* This table presents coefficients and sums of coefficients from linear regressions and, in parentheses, *p*-values corresponding to two-tailed tests of $H_0$: coefficient or sum of coefficients equals 0; in panels A and B, the one explanatory variable of interest is "Polygynous;" in panels C and D, the three explanatory variables of interest are "Polygynous," "Female playing partner," and the interaction between the two; in panel B, there are no *inter*-household model estimations because the focal sample is contributions in husband-wife interactions; *p*-values are adjusted to account for *inter*-dependence within workshops using a wild bootstrap (Cameron, Gelbach, and Miller 2008); in panel C, "Female Playing Partner (FPP)" and the interaction term drop out of the intra-household models because husbands play all of their *intra*-household games with women (their wives); in panel D, "Female Playing Partner (FPP)" drops out of the *intra*-household estimations for wives because monogamous wives play only with men (their husbands) and the coefficient on the interaction term identifies the difference in the contribution rates of wives of polygynous husbands when interacting with their co-wives and when interacting with their husbands. Controls are initial endowment, session size, order of play in session, delay identifier, second/third session in community identifiers, second/third game in session identifiers, enumerator identifiers, participant age, education, ethnicity, religion, earning identifier, wealth, urban identifier, and log number of children (with one added before applying the log transformation). For the full definitions of these controls, see the note for online Appendix Table A2.

difference in polygynous wives' contribution rates depending on whether they are interacting with their husbands or their co-wives.

## D. *Selection versus Causation*

Next, we investigate whether the difference in contribution rates between monogamous and polygynous households is causal, i.e., being in a polygynous marriage causes people to be less cooperative, or owing to selection, i.e., less cooperative people select into polygyny.

If cooperation is lower in polygynous households as a result of selection, we would expect members of polygynous households to be less cooperative also when playing with members of other households, i.e., when playing *inter*-household games. The whiskered white circles in panel B of Figure 1 indicate the mean contribution rates by the same samples of spouses but when playing with members

of other households. Contributions by both monogamous and polygynous spouses were significantly lower in *inter*-household games and, if anything, the contribution rate for the monogamous spouses was lower (36 percent) than the contribution rate for the polygynous spouses (39 percent).[16] In Table 2, columns 3–4, we show that this difference is statistically insignificant for the full sample (Panel A).

Focusing on the husbands, in Table 2, panel C, columns 3–4, we investigate whether men who select into polygynous marriage are less cooperative toward others in general and toward women specifically. We do the latter by including an indicator for whether the playing partner was female and the interaction between this and *Polygynous* in the analysis. The insignificance of the coefficient on *Polygynous* indicates that there was no difference in the contribution rates of monogamous and polygynous husbands when they were playing with men from other households. The insignificance of the coefficient on the interaction between *Polygynous* and *Female playing partner* indicates that playing with a woman rather than a man from another household did not affect contribution rates differently for polygynous versus monogamous husbands. Finally, the insignificance of the sum of the coefficients on *Polygynous* and the interaction term indicates that there was no difference in the contribution rates of polygynous and monogamous husbands when they were playing with women from other households.

Turning to the wives, the insignificant coefficients on *Polygynous* in Table 2, panel D, columns 3–4, indicate that we cannot reject the null hypothesis that the wives of monogamous and polygynous husbands were equally cooperative when playing with men to whom they were not married.

Finally, consider the finding that the contribution rates of co-wives when playing with each other were lower than when they were playing with their husbands (see Table 2, panel D, column 1). As the critical difference is *within* wife, this cannot be owing to the selection of women into polygyny based on their cooperativeness with other people. However, women who are less inclined to cooperate with other women, while being no less inclined to cooperate with men, could have selected into polygynous marriage. The statistical insignificance of the coefficient on the interaction between *Polygynous* and *Female playing partner* in Table 2, panel D, column 3, indicates that we cannot reject the null that in *inter*-household games, playing with a woman did not affect contribution rates differently for wives of monogamous versus polygynous husbands.

In sum, these estimations offer no evidence of selection of men and women into polygyny based on either their cooperativeness with other people in general or their differential willingness to cooperate with men and women. Thus, we conclude that the lower cooperation rate within polygynous marriage groups was owing to an effect of the marriage institution rather than selection. Polygyny causes spouses to be less cooperative, one with another. Further, within polygynous marriages, wives are even less cooperative with their co-wives than they are with their husbands.

[16] These contribution rates are similar to those observed in public good games around the world. For example, Wilkinson and Klaes (2012) indicates that, in general, anonymously matched unmarried subjects contribute about half of their endowments.

### E. *The Conditioning of Cooperation on Beliefs about Others' Cooperativeness*

One possible explanation for the difference in *intra*-household cooperativeness between monogamous and polygynous marriage groups is that the behavioral foundations of cooperation vary across the two types. Cooperation can be motivated by altruism, in which case husbands and wives will not deviate from full cooperation even when they believe that their spouse is likely to do so. Adherence to a strong cooperative norm would have a similar effect. Alternatively, cooperation may be based on reciprocity and, hence, conditional on the cooperation of others. In this case, husbands and wives will deviate from full cooperation when they believe that their spouse or co-wife will do likewise. More conditional and less altruistic or norm-driven, unconditional cooperation could explain the lower cooperation rate within polygynous households. Using data on participants' beliefs about their playing partners' contributions, we can undertake a preliminary investigation into whether participants' own contributions are conditioned on beliefs about others' contributions and whether this varies across monogamous and polygynous households.[17]

Figure 3 presents the estimated linear relationships between husbands' and wives' own contributions and their beliefs about their playing partners' contributions for: monogamous husbands and wives when playing with each other (solid dark, purple line), polygynous husbands and their wives when playing with each other or wives with their co-wives (solid light, green line), monogamous husbands and wives when playing with members of other households (dashed dark, purple line), polygynous husbands and their wives when playing with members of other households (dashed light, green line).[18]

Focusing, first, on *intra*-household interactions, husbands and wives who believed that their spouses or co-wives would contribute 100 percent of their initial endowments chose to contribute 95 percent of their own initial endowment, on average, regardless of whether their household was monogamous or polygynous. However, husbands and wives who believed that their spouses or co-wives would contribute less than 100 percent conditioned their own contributions differently depending on whether their household was monogamous or polygynous.

Within monogamous households, a 10 percentage point reduction in belief about a spouse's contribution is associated with a 4 percentage point reduction in one's own contribution. Within polygynous households, a 10 percentage point reduction in belief about a spouse's or co-wife's contribution is associated with a significantly ($p = 0.006$) larger 7 percentage point reduction.[19] This analysis, combined with the histogram in the panel A of Figure 1, indicates that full cooperation is a common reference point for members of both monogamous and polygynous households, but that they respond differently when they anticipate that their spouses or co-wives are

[17] The usefulness of this analysis depends on the quality of the beliefs data. If the elicited beliefs are inaccurate or biased and the inaccuracy or bias differs between members of monogamous and polygynous households, the validity of our comparative findings would be undermined. Online Appendix Section 4 and Table A9 present the beliefs data and rule out concerns about its quality.

[18] Figure 3 is derived from the regressions presented in online Appendix Table A10, columns 1 and 3.

[19] These findings are robust to the inclusion of experimental and socioeconomic controls (see online Appendix Section A4 and Table A10). When the controls are added, we also find that cooperation is significantly more conditional between co-wives as compared to between polygynous husbands and their wives ($p = 0.070$).

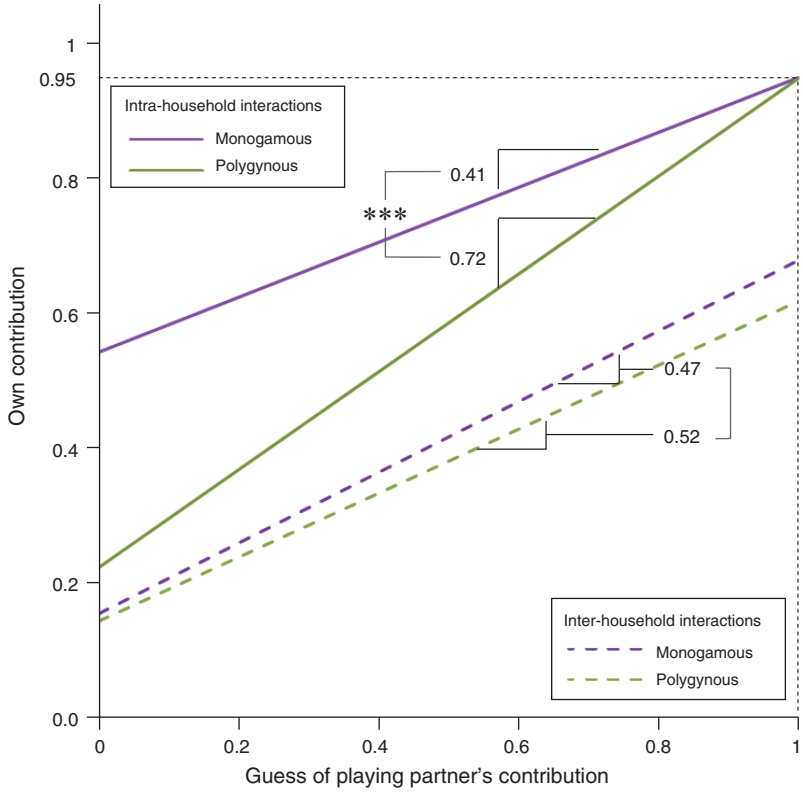


FIGURE 3. THE CONDITIONING OF OWN COOPERATION ON BELIEFS ABOUT PLAYING PARTNERS' COOPERATION AMONG MONOGAMOUS AND POLYGYNOUS SPOUSES

*Notes:* The two solid lines are derived from a single linear regression in which the dependent variable is own contribution when interacting with spouse or co-wife; the two dashed lines are derived from a single linear regression in which the dependent variable is own contribution when interacting with a member of another household; potential dependence within workshops is accounted for using a wild bootstrap. *** = slopes significantly different from zero at the 1 percent level.

going to deviate from this reference point. A closer inspection of the data reveals that the difference between the estimated relationships is primarily owing to differences in the relative frequencies of full unconditional versus conditional cooperation.[20]

Here, once again, we can exploit the *inter*-household PGGs involving the same husbands and wives to investigate whether being in a polygynous marriage causes individuals to become more reciprocally cooperative with their spouses and co-wives or whether more reciprocating types are more likely to select into polygynous marriages. We cannot reject the null that the purple and green dashed lines in Figure 3 have the same intercept and the same slope. When playing with members of other households, a 10 percentage point reduction in belief about a playing partner's contribution is associated with a 5 percentage point reduction in one's own contribution.[21]

[20] See online Appendix Section 4 and Table A11 for details.

[21] Online Appendix Table A10 indicates that these findings are robust to the inclusion of experimental and socioeconomic controls.

It is also worth noting that the conditioning of cooperation on beliefs differs markedly depending on whether the interaction is *intra*- or *inter*-household. In the former, cooperation tends to be either high and unconditional or conditional. In the latter it tends to be either minimal and unconditional or conditional.[22]

To sum up, monogamous spouses are more inclined to be unconditionally cooperative, that is, they contribute (almost) their entire initial endowment irrespective of how much they expect their spouse to contribute. In contrast, when polygynous household members expect their spouses or co-wives to deviate from full cooperation, they are more inclined to make conditionally cooperative decisions, that is, to contribute approximately the same amount as they expect their spouse or co-wife to contribute. Thus, cooperation appears motivated more by altruism or adherence to a strict cooperative norm in monogamous households and more by reciprocity in polygynous households. Finally, there is no evidence to suggest that individuals select into polygyny depending on how they condition their cooperativeness on their beliefs about others' cooperativeness.

## III. Conclusion

Using a carefully designed experiment to measure cooperation between all possible interacting pairs within monogamous and polygynous households, we find that, while *intra*-household cooperation is high and the majority of spouses aim to maximize joint utility, cooperation is lower within polygynous compared to monogamous households. In part, this is because cooperation is lower between polygynous husbands and their wives as compared to monogamous husbands and their wives and, in part, this is because cooperation is particularly low between co-wives. In contrast, we find no differences in cooperativeness between monogamous and polygynous spouses when they interact with men or women from other households, indicating that the differences in *intra*-household cooperation are causal rather than owing to selection.

Turning to behavioral foundations, we find that cooperation between monogamous spouses tends to be unconditional and consistent with high levels of pure altruism or strict adherence to norms of spousal cooperation. In comparison, cooperation between polygynous spouses and co-wives tends to be more reciprocal, a considerable proportion cooperating only to the extent that they believe the other with whom they are interacting will cooperate. Further, when playing with members of other households, there is no difference in how monogamous and polygynous spouses condition their contributions on beliefs about the other's contribution, indicating that the differences in the foundations of cooperation between monogamous and polygynous households are not owing to reciprocal types being more inclined to select into polygyny.

The experiment was designed to document whether and how cooperation differs between polygynous and monogamous households and to rule out potential selection of less cooperative individuals into polygyny. While there is more research to be

[22] See online Appendix Section 4 and Table A11 for details.

done, especially with regard to the behavioral and other mechanisms underpinning the differences in cooperation that we observe, our findings provide a strong foundation upon which to build.

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